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(71) Applicant *(for all designated States except US)*: **METSO PAPER, INC.** [FI/FI]; Fabianinkatu 9 A, FIN-00130 Helsinki (FI).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **LAAPOTTI, Jorma** [FI/FI]; Raponkuja 6, FIN-40270 Palokka (FI).

(74) Agent: **FORSSÉN & SALOMAA OY**; Eerikinkatu 2, FIN-00100 Helsinki (FI).

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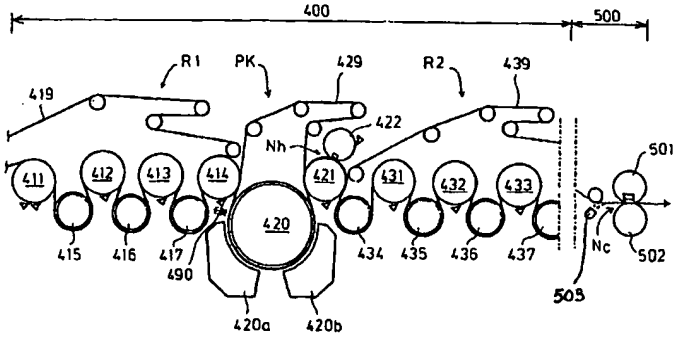
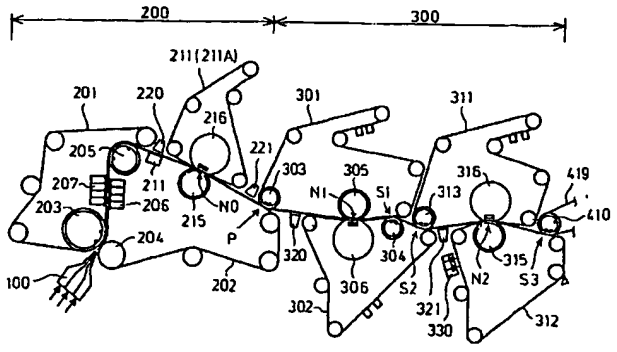
(54) Title: METHOD FOR THE MANUFACTURE OF PAPER OR BOARD





(57) Abstract: Stock is fed from a headbox (100) to a gap former (200) in which water is removed from a web in two directions. The web formed in the gap former is passed to a press section (300) comprising at least one extended nip (N1, N2), in which press section water is removed from the web by pressing and in which the last press nip (N2) is single-felted. In that connection, the density of the web surface which is in the direction of removal of water becomes higher than the density of the opposite surface. The web pressed in the press section is passed to a dryer section (400) in which the web is dried applying at least cylinder drying (R1, R2, R3), after which the web is passed to an end calender (500) in which the web is calendered. After the press section, heating is applied by at least one hot pre-calendering device (Nh) to that surface of the web which is placed against a substantially impervious press surface in the last press nip (N2) of the press section, whereby the fibres of the web surface having a lower density are heated and water is evaporated and transferred to the opposite surface of the web.

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Method for the manufacture of paper or board

The invention relates to a method for the manufacture of paper or board according to the preamble of claim 1.

The invention relates to a paper- or boardmaking line of the kind in which the last press nip of a press section is single-felted. In such a press nip, water is removed from a web substantially only in one direction. This last press nip is often also under a high load. In this kind of situation, the web is formed asymmetric in respect of its Z-direction density distribution, surface pore volumes, absorption properties and printability properties. In the single-felted press nip in the press section, the density of the web becomes higher on the surface which is facing a press felt, i.e. on the side of dewatering. The density of the web surface which is facing a substantially water-impervious press backup surface remains lower. This is due to the fact that, in a compression situation, the internal hydraulic pressure of the web carries a large part of the total compression pressure. In that connection, the pressure which compresses the fibre mess in the web and makes it denser is higher on the dewatering side than on the side of the smooth, substantially water-impervious backup surface.

With respect to the prior art, reference is made to **FI patent application 991096, FI patent 104100, WO patent publication 95/30049,** and **FI patent application 981331,** which are described briefly below.

FI patent application 991096 discloses a method and a paper machine line, in particular for the manufacture of fine paper. The paper machine line comprises a short circulation the stock volume of which has been minimized, a headbox, a gap former, a press section comprising at least one extended-nip press, a dryer section with at least a portion of it based on impingement drying, a pre-calender, a two-

sided pre-coater and a drying section after it, an on-line coating station/stations and, after it/them, an after-drying section/sections mainly based on contact-free drying, an on-line calender whose linear loads can be regulated separately in each nip, and a reel-up.

FI patent 104100 discloses an integrated paper machine. The paper machine comprises, in the running direction of the web, a multi-layer headbox, a gap former including at least one pre-press, a press section including at least one extended-nip press, a pre-dryer section in which the web is dried by means of a high-capacity dryer unit, a dryer section which includes at least one dryer group applying single-wire draw as well as a surface treatment device for the web. The paper machine comprises a closed draw at least to the end of the dryer section. The patent also describes a hot pre-calendering nip situated in the dryer section and formed between a drying cylinder and a roll.

WO publication 95/30049 also describes a hot pre-calendering nip situated in a dryer section and formed between a drying cylinder or a Yankee cylinder and a roll.

FI patent application 981331 discloses a method and a paper machine for the manufacture of paper. The method and the paper machine are most appropriately suited for the manufacture of glossy and porous paper for colour powder printing. The paper machine comprises a headbox, a wire section, a press section, a dryer section, a coating section, an after-dryer section, a calender, and a reel-up. The headbox and the wire section are formed such that paper is provided with a desired composition layer in the Z-direction and that the calender is a calendering device that maintains or at least substantially retains the porosity of the paper web it had before calendering.

An object of the invention is to correct the above-mentioned asymmetry caused in the web by the last single-felted press nip. A particular aim of the invention is to

correct the asymmetry of the absorption properties of the web. Because of asymmetric absorption properties, the absorption of printing ink in paper or board is different from the different surfaces of paper or board. Printing ink is absorbed better and more quickly into a porous surface than into a dense surface. In the case of coated fine paper and LWC paper, coating at least partly remedies this asymmetry, but in the case of uncoated newsprint and SC paper, it is a burning problem. Attempts have been made to remedy the problem, for example, such that to a press provided with a centre roll a separate inverted press nip is added after the centre roll, in which press nip the dewatering direction is opposite to the dewatering direction of the last press nip of the centre roll.

The method for the manufacture of paper or board according to the invention is mainly characterized by the disclosure in the characterizing part of claim 1.

The invention can be applied in all paper or board machines in which the last nip of the press section is single-felted. The press section can comprise merely separate press nips or merely press nips defined against the centre roll or combinations of these.

In the invention, an efficient heating/drying stage after the press section is applied to the web to the surface of the web having a lower density. The dry solids content of the web after the press section is typically in a range of from 55 % to 70 %. Heating is accomplished in at least one hot pre-calendering unit in which the web surface having a lower density is against a backup surface which is at a higher temperature and the web surface having a higher density is against a backup surface which is at a lower temperature. In addition to this, said web surface can be subjected to air impingement, advantageously at the beginning of the dryer section, whereby the fibres of the web surface having a lower density are heated, water is evaporated and transferred to the opposite surface of the web having a higher density. By means of heating, in particular by hot pre-calendering, attempts are made to equalize the density symmetry of the web. The hot pre-calendering

unit may be formed of one or more pre-calendering nips in which both backup surfaces are heatable or in which only one backup surface is heatable.

Impingement drying is an efficient method of transferring water to the opposite surface of the web. Impingement drying provides a drying efficiency that is about threefold compared to cylinder drying of equal length.

In addition to the above-mentioned heating/drying stage and hot pre-calendering stage, the density distribution of the web can be further corrected by using one or more of the following methods of correcting the density distribution of the web:

- Using a multi-layer headbox in which there are at least two stock feed layers. In that connection, it is possible to feed more fines and/or fillers, and/or stock size and/or retention aid to that surface of the web which in the last single-felted press nip is placed against a substantially water-impervious backup surface.

- Using a higher vacuum and/or a longer vacuum zone and its time of action in that dewatering unit of the twin-wire zone in the forming section which is facing the web surface which in the last single-felted press nip is placed against a substantially water-impervious backup surface.

- Using in the forming section a denser wire on that side of the web surface which in the last single-felted press nip is placed against a substantially water-impervious backup surface.

- Removing in a pre-press nip of the forming section more water through that surface of the web which in the last single-felted press nip is placed against a substantially water-impervious backup surface. This can be affected, among other things, by selections of hollow faces and fabrics.

- Heating the web after a twin-wire zone of the forming section by means of heating devices placed before and/or after a pre-press nip and/or in the press section by means of heating devices placed before and/or after the press nips of the press section to a larger extent on that surface of the web which in the last single-felted press nip is placed against a substantially water-impervious backup surface. The heating devices can be steam boxes or infrared dryers. By using infrared dryers, any additional water produced through evaporation of steam on the web surface having a lower density is avoided.

- Subjecting that surface of the web which in the last single-felted press nip is against a substantially water-impervious backup surface to a web sizing treatment in the press section before the last press nip and/or in the dryer section before impingement drying. The sizing is carried out, for example, by spraying or extruding size onto the transfer belt of the last press nip using a size whose water content is as low as possible. The sizing step can also be accomplished at the beginning of the impingement drying of the dryer section. The sizing agent may also contain paste, i.e. it may also comprise filler and pigment.

- Carrying out end calendering by using in the end calendering nip a higher temperature of the backup surface on that surface of the web which in the last single-felted press nip is against a substantially water-impervious backup surface. The end calendering nip can be a roll nip or an extended nip and the end calendering stage can comprise one or more calendering nips. The increase in the density of the more porous surface of the web in the end calendering nip or nips can be enhanced by spraying water and/or steam to the web surface on the more porous side before the end calendering nip or nips.

To make both the absorption symmetry and the roughness symmetry of the web good may require an appropriate compromise between the two symmetries.

Selections of suitable roughness levels for fabrics and backup surfaces assist in achieving a good roughness symmetry.

In the following, some paper- or boardmaking lines in accordance with the method of the invention are described with reference to the figures in the appended drawings, to the details of which the invention is, however, not meant to be exclusively limited.

Figure 1 shows one forward end of a paper- or boardmaking line carrying out the method in accordance with the invention.

Figure 2 shows one rear end of the manufacturing line shown in Fig. 1.

Figure 3 shows one alternative rear end of the manufacturing line shown in Fig. 1.

Figure 4 shows one alternative forward end of the manufacturing line.

Figure 5 shows one rear end of the manufacturing line shown in Fig. 4.

Figure 6 shows one alternative forward end of the manufacturing line.

Figure 7 shows one alternative rear end of the manufacturing line.

The paper- or boardmaking line carrying out the method in accordance with the invention comprises, in the running direction of the web, a headbox 100, a gap former 200, a press section 300, a dryer section 400, and an end calender 500.

Fig. 1 shows the forward end of the line, i.e. the headbox 100, the gap former 200, and the press section 300. The headbox 100 is advantageously a dilution headbox and it may also comprise layering of fibres and/or fillers and/or fines and/or additives. The gap former 200 comprises a first wire loop 201 and a second wire

second wire loop 202, there is a suction box 211 for drawing the web into contact with the second wire 202 after the twin-wire zone.

After the pre-press nip N0, the web is passed further on support of the second wire 202 to a pick-up point P where the web W is separated from the second wire 202 on a pick-up suction roll 303 and transferred on support of a first press felt 301, i.e. a pick-up felt, to the press section 300.

In the press section 300, the web is passed between the first upper press felt 301 and a second lower press felt 302, between which the web W runs into a first press nip N1. The first press nip N1 is an extended nip which is formed of a lower shoe roll 306 provided with a loading shoe and a belt shell and of an upper hollow-faced counter roll 305. After the first press nip N1, the web is separated from the first press felt 301 at a first transfer point S1 by means of the vacuum of a first transfer suction roll 304 located inside the second press felt loop 302 and caused to adhere to the second press felt 302. After that, the web is transferred on support of the second press felt 302 to a second transfer point S2 where the web is separated from the second press felt 302 by means of the vacuum of a second transfer suction roll 313 located inside a third press felt loop 311 and caused to adhere to the third press felt 311. After that, the web is transferred on support of the third press felt 311 to a second press nip N2. The web runs in the second press nip N2 between the third upper press felt 311 and a lower transfer belt 312. The second press nip N2 is an extended nip which is formed of an upper shoe roll 316 provided with a loading shoe and a belt shell and of a lower hollow-faced counter roll 315. After the second press nip N2, the web is separated from the third press felt 311 and transferred on support of the transfer belt 312 to a third transfer point S3 where the web is separated from the transfer belt 312 by means of the vacuum of a fourth transfer suction roll 410 located inside a drying wire loop 419 of a first dryer group R1 of a dryer section 400. After that, the web W is transferred on support of said drying wire 419 to the dryer section 400.

The press section 300 may additionally comprise a third heating device 320, which can be located before the first press nip N1, and a fourth heating device 321, which can be located before the second press nip N2. The heating devices 320, 321 are located in connection with a free surface of the web, and they can be used for applying a local heating effect on the web, which enhances the removal of water in the press nip. The press section 300 may also comprise a size feed device 330, which can be located in connection with the transfer belt 312 serving as the lower press fabric of the second press nip N2, in which connection sizing is applied to that surface of the web which is against the transfer belt 312 in the last press nip N2. The sizing can be carried out, for example, by spraying or extruding before the second press nip N2 onto the transfer belt 312, preferably using a size or a paste the water content of which is as low as possible.

Fig. 2 shows a rear end of the manufacturing line shown in Fig. 1, i.e. a dryer section 400 and an end calender 500. Only the beginning of the dryer section 400 is illustrated, showing a first cylinder dryer group R1 applying single-wire draw, an impingement drying unit PK situated after that and a second cylinder dryer group R2 applying single-wire draw situated after that. The first cylinder dryer group R1 is a downwardly open cylinder dryer group R1, in which heated drying cylinders 411, 413, 413, 414 are above and reversing suction rolls 415, 416, 417 are below.

The web is brought to the dryer section 400 on support of the drying wire 419 of the first cylinder dryer group R1. After that, the web runs along a meandering path between the cylinders 411, 412, 413, 414 and the reversing suction rolls 415, 416, 417 of the first cylinder dryer group R1.

From the last drying cylinder 414 of the first cylinder dryer group R1 the web is transferred at a contact point between said drying cylinder 414 and a drying wire 429 of the impingement drying unit PK onto the drying wire 429 of the impingement drying unit PK, on support of which the web is transferred to a

suction cylinder 420 which is located below the floor level of the paper machine hall and which has a large diameter, preferably a diameter in a range of from 3 to 6 m. The web is kept in contact with the outer surface of the drying wire 429 running around the suction cylinder 420 by means of the vacuum of the suction cylinder 420. On the suction cylinder 420, the web running on the outer surface of the drying wire 429 of the impingement drying unit is subjected to air impingement by means of impingement units 420a and 420b disposed in connection with the suction cylinder 420. The air impingement is directed at that surface of the web which was against the transfer belt 312 in the last press nip N2 of the press section 300. The temperature of the blowing air is in a range of from 150 to 450 °C and the flow of air in the blow nozzles placed against the web is in a range of from 50 to 150 m/s.

From the suction cylinder 420 the web returns, on support of the drying wire 429 of the impingement drying unit, above the floor level of the paper machine hall and is transferred, at a contact point between the drying wire 429 of the impingement drying unit and a thermo roll 421 of a hot pre-calender, onto the surface of said thermo roll 421 of the hot pre-calender. The web is transferred on the surface of the thermo roll 421 of the hot pre-calender to a hot pre-calendering nip Nh defined between the thermo roll 421 and a backup roll 422 of the hot pre-calender. In the hot pre-calendering nip Nh, that surface of the web which was against the press belt 312 in the last press nip N2 of the press section 300 is placed against the hot shell of the thermo roll 421. The hot roll 421 of the hot pre-calendering nip Nh can be formed of a drying cylinder or of a separate thermo roll, and its temperature is in a range of from 80 to 250 °C.

After the hot pre-calendering nip Nh, the web is transferred on the surface of the thermo roll 421 of the hot pre-calender to a contact area between a drying wire 439 of the second cylinder dryer group R2 and said thermo roll 421 of the hot pre-calender, in which contact area the web is transferred onto the drying wire 439 of the second cylinder dryer group R2 and further onto a first reversing suction roll

434 of the second cylinder dryer group R2. After that, the web runs along a meandering path between drying cylinders 431, 432, 433 situated in an upper row of the second cylinder dryer group R2 and reversing suction rolls 434, 435, 436, 437 situated in a lower row.

The second cylinder dryer group R2 can be followed by a suitable number of cylinder dryer groups which apply single-wire draw and between which it is possible to regulate the necessary difference of draw , i.e. to maintain the desired tension of the web. The cylinder dryer groups may continue all the way to the end calender 500 with the same layout such that the drying cylinders are in the upper row and the reversing suction rolls are in the lower row. However, in the case of fine paper it is advantageous to make the last dryer group or the last two dryer groups before the end calender with a reverse layout, in which connection the drying cylinders in them are in the lower row and the reversing suction rolls are in the lower row. This arrangement reduces web curl. Curl of the web can also be reduced by steam treatments, known in themselves, in connection with a dryer section having the same layout throughout it.

The web is transferred from the last cylinder dryer group of the dryer section to the end calender 500, in which the web is calendered. The calender can comprise one or more calendering nips Nc and the calendering nips can be roll nips or extended nips. The end calender 500 is here a long-nip calender, which is formed of an upper shoe roll 501 and a lower thermo roll 502. In connection with the end calender 500 it is also possible to use a moisturizing device 503 for spraying water and/or steam to that surface of the web which is placed against the thermo roll 502. Moisturizing enhances the calendering effect such that the increase in the compressibility and density of the web surface lying against the thermo roll is intensified. The web surface placed against the thermo roll 502 is the same surface as is against a substantially water-impervious backup surface in the last press nip N2 of the press section 300. The web is passed from the end calender 500 to a reel-up (not shown in the figures), in which machine rolls are made of the web.

The dryer section 400 may also include a size feed device 490, which can be located in connection with the suction cylinder 420 of the impingement drying unit PK before the impingement units 420a, 420b, in which connection sizing is applied to that web surface which is against the transfer belt 312 in the last press nip N2.

Fig. 3 shows one alternative rear end of the manufacturing line. The first R1 cylinder dryer group and the impingement drying unit PK of the dryer section 400 correspond to those shown in Fig. 2, with the difference that the drying wire 429 of the impingement drying unit PK runs here a longer distance around the thermo roll 421 of the hot pre-calender than in the embodiment of Fig. 1. The web is transferred as a short open draw from a hot pre-calender nip Nh onto a first drying cylinder 431 of a second cylinder dryer group R2. After that, the web runs along a meandering path between drying cylinders 431, 432 and reversing suction rolls 433, 434 of the second cylinder dryer group R2. The second cylinder dryer group R2 is reversed such that the drying cylinders 431, 432 are in the lower row and the reversing suction rolls 433, 434 are in the upper row. The web is transferred from the last reversing suction roll 434 of the second cylinder dryer group R2 onto a drying wire 449 of a third cylinder dryer group R3 at a contact point formed by said reversing suction roll 434 and the drying wire 449 of the third cylinder dryer group R3. The third cylinder dryer group R3, of which only the beginning is shown, is again open downwards such that drying cylinders 441 are in the upper row and reversing suction rolls 442, 443 are in the lower row.

The dryer section 400 shown in Fig. 3 also continues with one or more cylinder drying groups applying single-wire draw, which groups have not been shown in the figure. The dryer section 400 is followed by an end calender 500 corresponding to that of Fig. 2 with its moisturizing device 503.

The forward end of the manufacturing line shown in Fig. 4 differs from the forward end shown in Fig. 1 in respect of the last press nip N2 of the press section 300. The last press nip N2 is formed here of a lower shoe roll 316 and an upper hollow-faced counter roll 315. In the last press nip N2, there is a press felt 311 as the lower fabric and a transfer belt 312 as the upper fabric. After the last press nip N2, the web follows the upper transfer belt 312, from which it is transferred with the help of a third transfer suction roll 410 onto a drying wire 469 of the first dryer group in the dryer section 400. Immediately after the third transfer suction roll 410 there is a suction box 451, by which the adherence of the web to the first drying wire 469 is ensured. A size feed device 330 is here in connection with the transfer belt 312 serving as the upper press fabric of the last press nip N2.

Fig. 5 shows a rear end of the manufacturing line shown in Fig. 4, i.e. a dryer section 400 and an end calender 500. The dryer section 400 begins here with a planar dryer section PK that applies air impingement. The web runs on support of a drying wire 469 of the planar dryer section TK along a substantially horizontal path. The drying wire 469 of the planar dryer section TK runs on support of guide rolls 462 and suction boxes 461 are placed between the guide rolls 462. An impingement unit 460 is placed above the web for blowing hot air against that surface of the web which is against the transfer belt 312 in the last press nip N2. In the initial portion of the drying wire 469 of the planar dryer section TK before the impingement unit 460, a size feed device 450 can be further used for applying size to the web surface which was against the transfer belt 312 (Fig. 4).

After the planar dryer section TK, the web is transferred, at a contact point between the drying wire 469 of the planar dryer section TK and a thermo roll 421 of a hot pre-calender, onto the surface of said thermo roll 421. The web is transferred on the surface of the thermo roll 421 to a hot pre-calendering nip Nh, which is formed between said thermo roll 421 and an unheated backup roll 422. The web surface which was against the transfer belt 312 in the last press nip N2 of the press section 300 is placed in the hot pre-calendering nip Nh against the

thermo roll 421 of the hot press. After the hot pre-calendering nip Nh, the web is transferred onto a transfer wire 471 in a contact area between the thermo roll 421 of the hot pre-calender and the transfer wire 471. On the transfer wire 471, the running direction of the web is turned with the help of a suction roll 470 situated inside the transfer wire loop 471. The web is transferred from the transfer wire 471 onto a drying wire 489 of a first cylinder dryer group R1 in a contact area between the transfer wire 471 and a suction roll 483 situated inside the second drying wire loop 489. The first cylinder dryer group R1 is formed of a downwardly open dryer group which applies single-wire draw and in which drying cylinders 481, 482 are in the upper row and reversing suction rolls 483, 484, 485 are in the lower row. The figure shows only a portion of the first cylinder dryer group R1. The dryer section continues with one or more cylinder dryer groups that apply single-wire draw.

The dryer section 400 is followed by the end calender 500, which comprises one or more calendering nips Nc, which may be roll nips or extended nips. The end calender 500 shown in the figure comprises one extended nip Nc defined between an upper thermo roll 501 and a lower shoe roll 502. A moisturizing device 503 is placed in connection with the end calender 500 before the calendering nip Nc for moisturizing the web surface placed against the thermo roll 501 of the end calender 500. Here again, it is a question of the web surface which in the last press nip N2 is against a substantially water-impervious surface, i.e. against the transfer belt 312 (Fig. 4). The moisturizing device 503 can be a water and/or steam moisturizing device and it enhances the calendering effect. By moisturizing it is possible to enhance the densification of the upper surface of the web in the end calendering nip Nc.

Fig. 6 shows one alternative forward end of the manufacturing line. This differs from the forward end shown in Fig. 1 in respect of the press section 300. The press section 300 is formed here only of one press nip N1. The press nip N1 is formed by an upper shoe roll 306 and a lower hollow-faced counter roll 305. In

the press nip N1 there is a press felt 301 as the upper press fabric and a transfer belt 302A as the lower press fabric. After the press nip N1, the web follows the transfer belt 302A, from which the web is separated at a transfer point by means of the vacuum of a transfer suction roll 410 situated inside a drying wire loop 419 of a first dryer group R1 of a dryer section 400. After that, the web W is passed to the dryer section 400 while supported by said drying wire 419. The rear end of the manufacturing line can be here like the one shown, for example, in Fig. 2.

Fig. 7 shows one alternative rear end of the manufacturing line. The dryer section 400 shown here does not comprise any impingement dryer part PK shown in Fig. 2. Instead, the web is transferred, after the last reversing suction roll 418 of a first cylinder dryer group R1 at a contact point between a first drying wire 419 and a thermo roll 421 of a hot pre-calender, onto the surface of the thermo roll 421 of the hot pre-calender. After a hot pre-calendering nip Nk, the web is transferred from the surface of the thermo roll 421 of the hot pre-calender at a contact point between said thermo roll 421 and a drying wire 439 of a second cylinder dryer group R2 onto said second drying wire 421. The second cylinder dryer group R2 corresponds to the second cylinder dryer group R2 shown in Fig. 2. The dryer section 400 continues with one or more cylinder dryer groups that apply single-wire draw. Before the hot pre-calender Nh, a size feed device 423 can be used to apply size to the web surface which was against the transfer belt 312, which size feed device is located in connection with the last reversing suction roll 418 of the first cylinder dryer group R1. The end calender 500 situated after the dryer section 400 corresponds to the end calender shown in Fig. 2 with its moisturizing device 503.

In the embodiments shown in Figs. 1, 4 and 6, the run of the web is supported and closed from the beginning of the forming section to the end of the press section. In the embodiment shown in Fig. 3, the run of the web includes a short open draw after the hot press situated in the dryer section 400. In the embodiments shown in

Figs. 2, 5 and 7, the run of the web is closed and supported through the entire dryer section.

In addition to the impingement drying devices PK, TK and the hot pre-calender Nh shown to be in the dryer section 400 in Figs. 2, 3, 5 and 7, the density distribution of the web can also be corrected by using one or more of the following methods of correcting the density distribution of the web:

- Using a multi-layer headbox 100 in which there are at least two stock feed layers. In that connection, it is possible to feed more fines and/or fillers, and/or stock size and/or retention aid to that surface of the web which in the last single-felted press nip N1, N2 is placed against a substantially water-impervious backup surface 302A, 312.

- Using a higher vacuum or a longer distance and time of action of vacuum in those dewatering units 203, 206, 207 of the twin-wire zone in the forming section which are facing that surface of the web which in the last single-felted press nip N1, N2 is placed against a substantially water-impervious backup surface 302A, 312.

- Using in the forming section a denser wire 201, 202 on that side of the web surface which in the last single-felted press nip N1, N2 is placed against a substantially water-impervious backup surface 302A, 312.

- Removing in a pre-press nip N0 of the forming section more water through that surface of the web which in the last single-felted press nip N1, N2 is placed against a substantially water-impervious backup surface 302A, 312. This can be affected, among other things, by selections of hollow faces and fabrics.

- Heating the web after the twin-wire zone of the forming section 200 by means of heating devices 220, 221 placed before and/or after a pre-press nip N0 and/or in the press section 300 by means of heating devices 320, 321, 322 placed before and/or after the press nips of the press section to a larger extent on that surface of the web which in the last single-felted press nip N1, N2 is placed against a substantially water-impervious backup surface 302A, 312. The heating devices 220, 221, 320, 321, 322 can be steam boxes or infrared dryers. By using infrared dryers, any additional water produced through evaporation of steam on the web surface having a lower density is avoided.

- Subjecting that surface of the web which in the last single-felted press nip N1, N2 is against a substantially water-impervious backup surface 302A, 312 to a web sizing treatment 330, 423, 450, 490 in the last press nip N1, N2 of the press section 200 and/or in the dryer section 300 before impingement drying PK, TK. The sizing is carried out, for example, by spraying or extruding size onto the transfer belt 302A, 312 of the last press nip N1, N2 using a size whose water content is as low as possible. The sizing step can also be accomplished at the beginning of the impingement drying PK of the dryer section 400. The size may also contain paste, i.e. it may also comprise filler and pigment.

- Carrying out end calendering by using in the end calendering nip or nips Nc a higher temperature of the backup surface 501, 502 on that surface of the web which in the last single-felted press nip N1, N2 is against a substantially water-impervious backup surface 302A, 312

- Spraying water and/or steam before the end calendering nip or nips Nc to that surface of the web which in the last single-felted press nip N1, N2 is against a substantially water-impervious backup surface 302A, 312..

In the embodiments illustrated in the figures, one press surface in the last press nip N1, N2 of the press section 300, which press surface is substantially water-impervious, is the transfer belt 302A, 312, but from the standpoint of the invention said press surface may also be formed of a smooth roll surface. In that case, the web runs in the last press nip N1, N2 between the press felt 301, 311 and a smooth-faced roll shell. The last press nip N1, N2 is thus still single-felted and dewatering takes place in one direction, i.e. into the water-receiving press felt 301, 311.

The embodiments illustrated in the figures show a press section 300 provided with separate press nips N1, N2 but, from the standpoint of the invention, the press section can also be formed of a press section which is provided with a centre roll and in which at least two press nips are formed against the centre roll. From the standpoint of the invention, the press section can, of course, also be a press section provided with separate nips and a centre roll.

The problem underlying the invention and relating to the asymmetry of the web arises from the fact that the last press nip of the press section is single-felted, in which connection the removal of water from the web takes place in it mainly in one direction.

The claims are presented in the following and the details of the invention may vary within the inventive idea defined by said claims and differ from the disclosure given above by way of example only.

Claims

1. A method for the manufacture of paper or board comprising the following steps:

- stock is fed from a headbox (100) to a gap former (200) in which water is removed from a web in two directions,
- the web formed in the gap former (200) is passed to a press section (300) comprising at least one extended nip (N1, N2), in which press section water is removed from the web by pressing and in which the last press nip (N1, N2) is single-felted such that water is removed in it substantially only in one direction, in which connection the density of the web surface which is in the direction of removal of water becomes higher than the density of the opposite surface,
- the web pressed in the press section (300) is passed to a dryer section (400) in which the web is dried applying at least cylinder drying (R1, R2, R3),
- the web dried in the dryer section (400) is passed to an end calender (500) in which the web is calendered,

characterized in that:

- after the press section (300), heating is applied by at least one hot pre-calendering device (Nh) to that surface of the web which is placed against a substantially water-impervious press surface in the last press nip (N1, N2) of the press section (300), whereby the fibres of the web surface having a lower density are heated and water is evaporated and transferred to the opposite surface of the web, i.e. to the surface having a higher density.

2. A method as claimed in claim 1, **characterized** in that, after the press section (300), in addition to the hot pre-calendering (Nh), heating is applied by an impingement drying device (PK,TK) to that surface of the web which is placed

against a substantially water-impervious press surface in the last press nip (N1, N2) of the press section (300).

3. A method as claimed in claim 2, **characterized** in that the impingement drying is carried out in an impingement drying unit (PK) placed in the dryer section (400), in which impingement drying unit the web is passed to a large-diameter suction cylinder (420) placed below the floor surface of the paper machine hall, on which suction cylinder hot air is blown on the web surface having a lower density by means of impingement units (420a, 420b) placed in connection with the suction cylinder (420).

4. A method as claimed in claim 2, **characterized** in that the impingement drying is carried out in a planar dryer unit (TK) which is situated after the press section (300) and in which hot air is blown by an impingement unit (460) on the web surface running in a plane and having a lower density .

5. A method as claimed in claim 3 or 4, **characterized** in that the hot pre-calendering (Nh) is carried out in a hot pre-calender which is situated after the impingement drying (PK, TK) and in which the web surface having a lower density is placed against a backup surface having a higher temperature in the hot pre-calender and the surface having a higher density is placed against a backup surface having a lower temperature.

6. A method as claimed in claim 5, **characterized** in that the hot pre-calendering (Nh) is carried out in a roll nip in which one roll is an unheated roll (422) and the other roll is a thermo roll (421), in which connection the web surface having a lower density is placed against the hot outer surface of the thermo roll (421) and the surface having a higher density is placed against the outer surface of the unheated roll.

7. A method as claimed in claim 5, **characterized** the hot pre-calendering (Nh) is carried out in an extended nip in which a shoe roll forms the unheated roll (422) and the backup roll (421) is a thermo roll, in which connection the web surface having a lower density is placed against the hot outer surface of the thermo roll (421) and the surface having a higher density is placed against the outer surface of the unheated roll.

8. A method as claimed in any one of claims 1 to 7, **characterized** in that end calendering (500) is carried out using in a calendering nip (Nc) or nips a higher temperature on that surface of the web which is against a substantially impervious press surface in said last press nip (N1, N2) of the press section (300).

9. A method as claimed in any one of claims 1 to 8, **characterized** in that the web surface which in said last press nip (N1, N2) of the press section (300) is against a substantially impervious press surface is moisturized before end calendering (500).

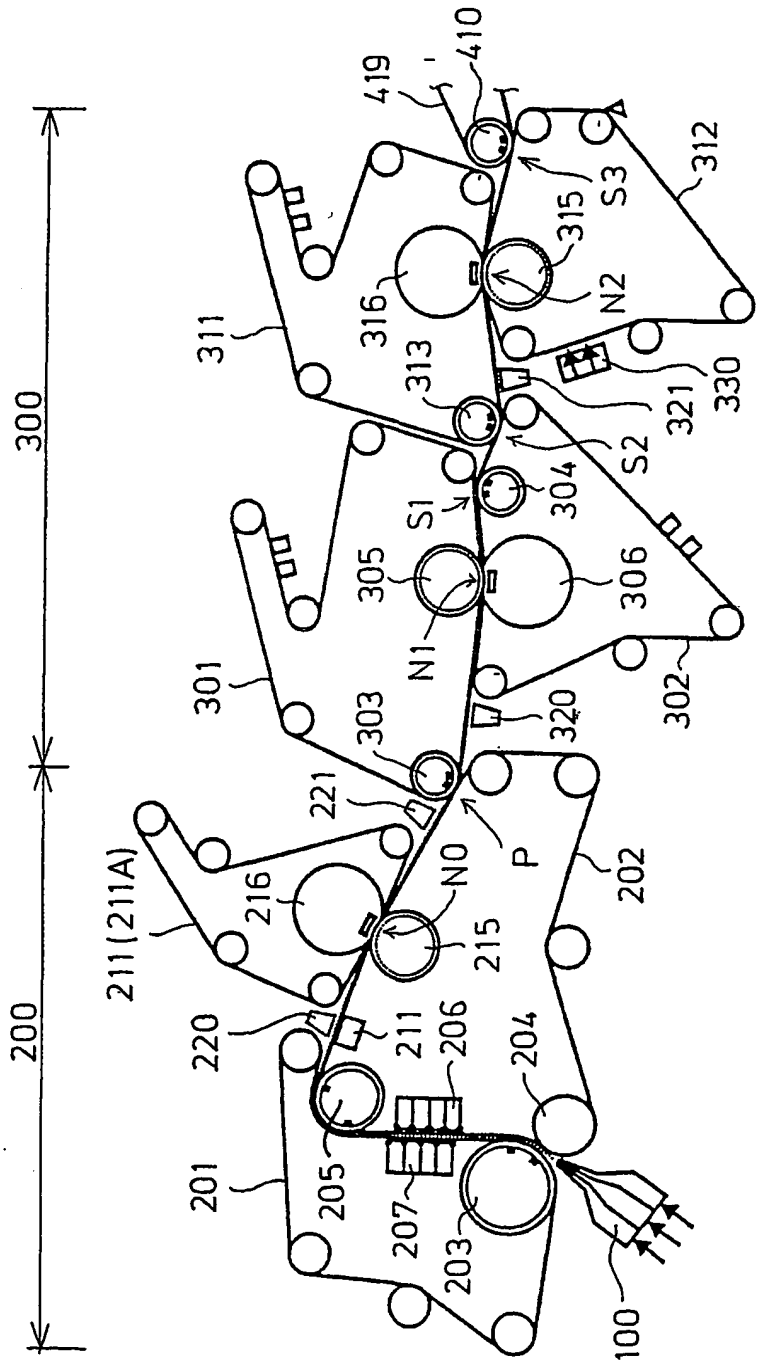

300
200
211(211A)
220
201
205
207
203
206
211
204
216
215
N0
P
202
221
303
320
301
N1
305
306
302
S1
304
313
316
S2
321
330
311
315
N2
S3
312
419
410
100

FIG. 1

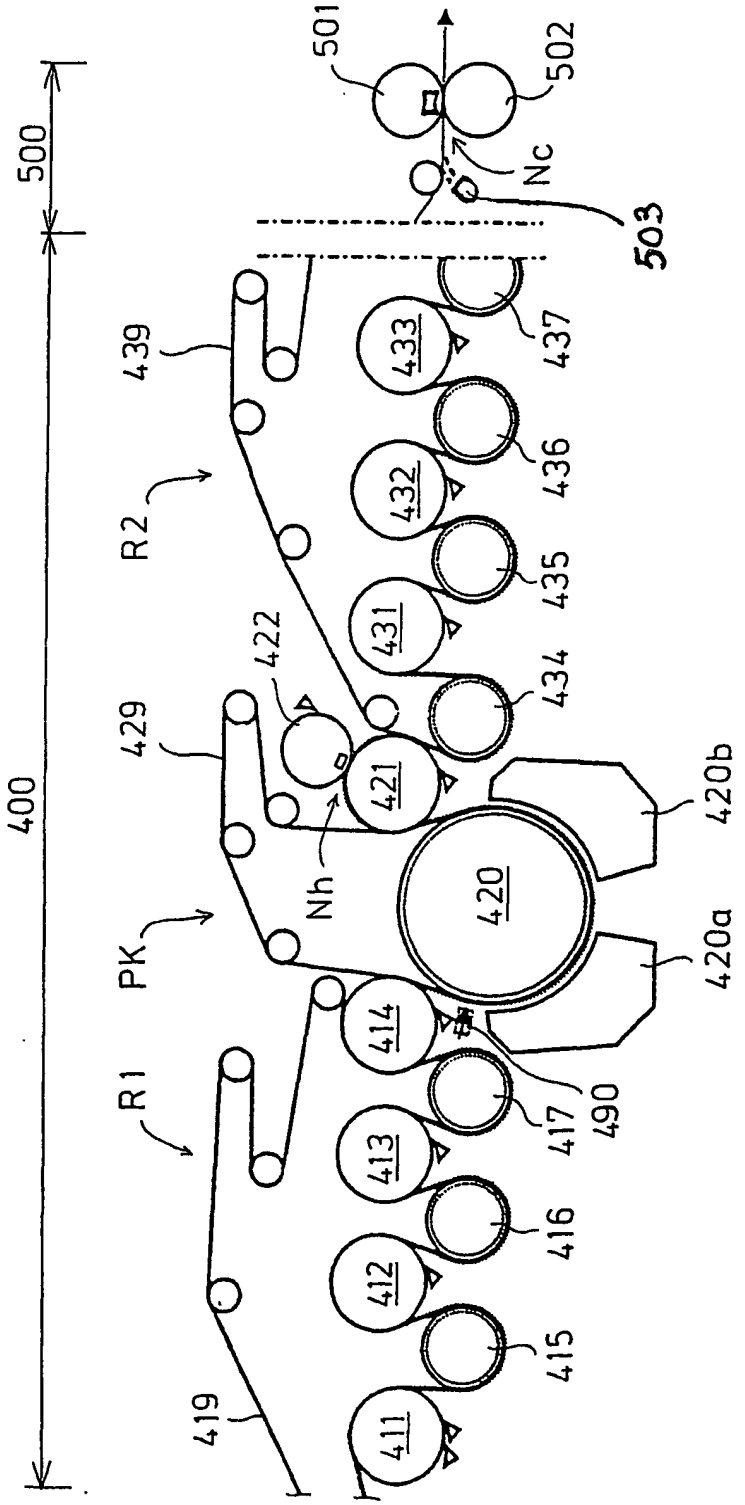
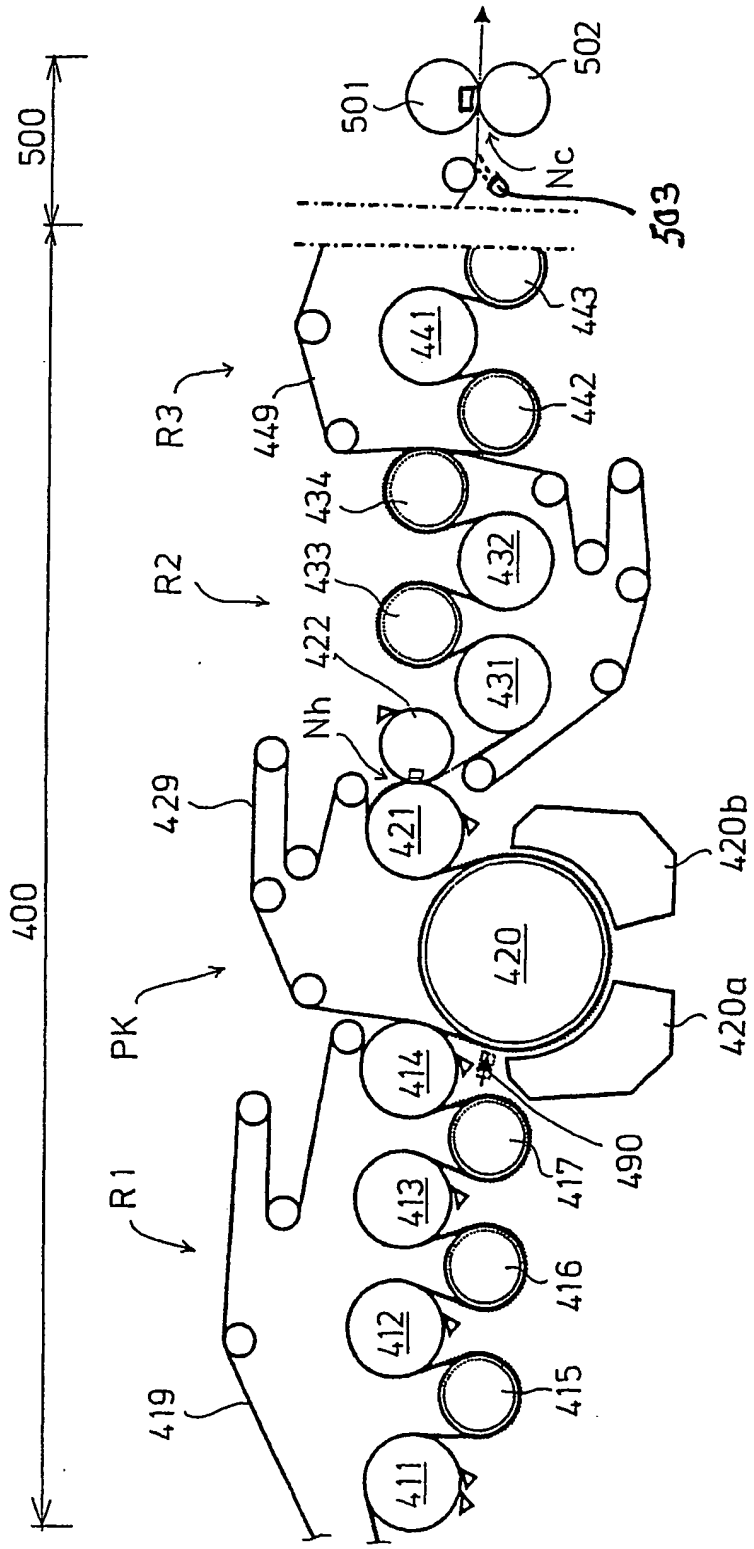

501
502
Nc
503
500
400
439
437
433
436
R2
432
435
431
422
434
429
421
420b
Nh
420
PK
420a
414
R1
417
490
413
416
412
415
419
411

FIG. 2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400
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502
Nc
503
443
441
442
449
R3
434
432
433
R2
422
431
Nh
429
421
420b
420
420a
PK
414
490
417
R1
413
416
412
415
419
411

FIG. 3

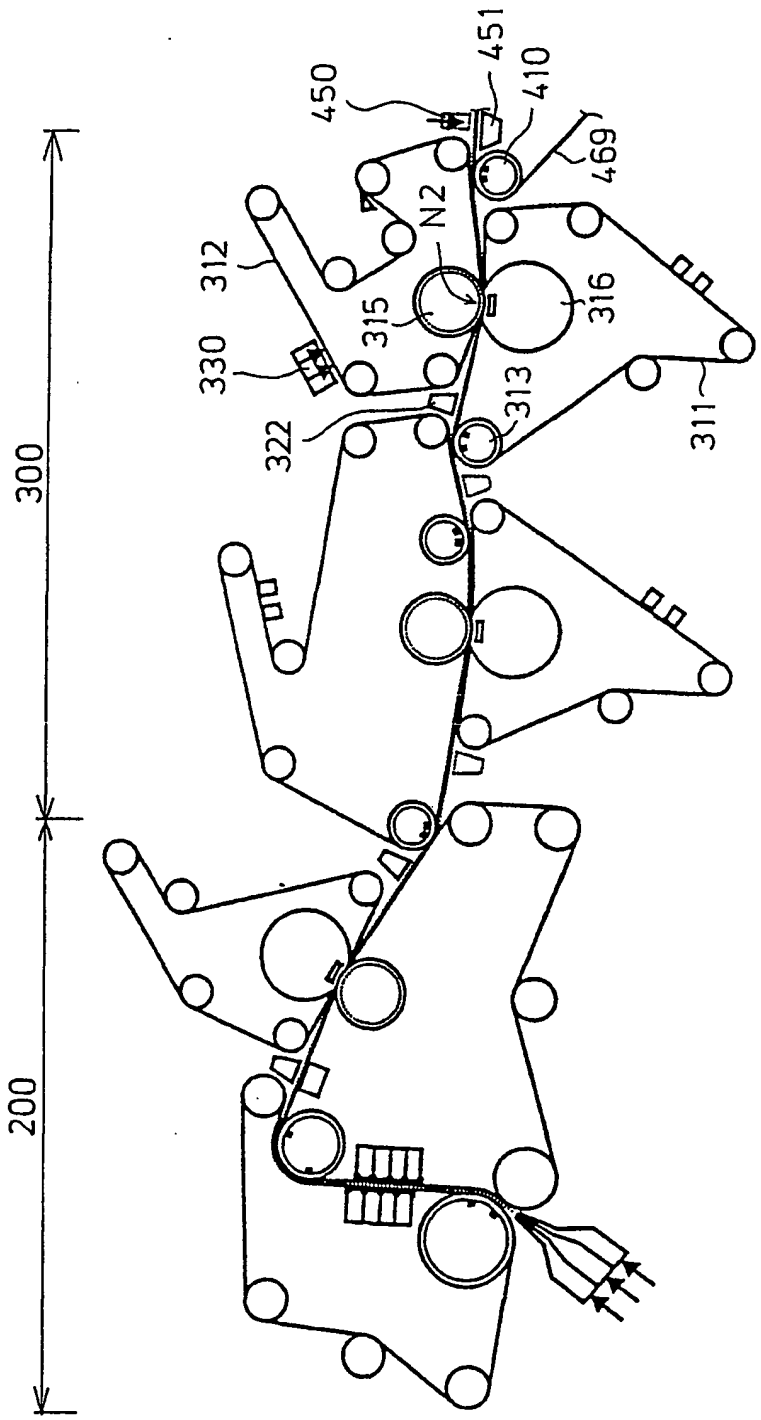

FIG. 4

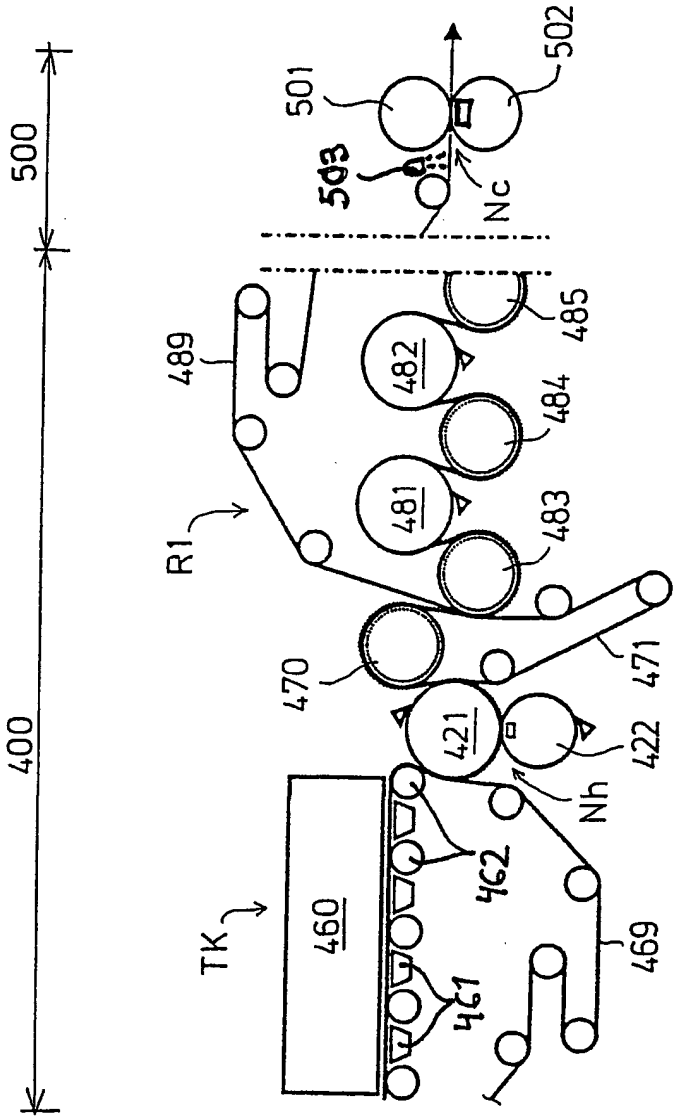
500
400
501
502
503
Nc
485
489
482
484
481
483
R1
470
471
421
422
Nh
462
TK
460
469
461

FIG. 5

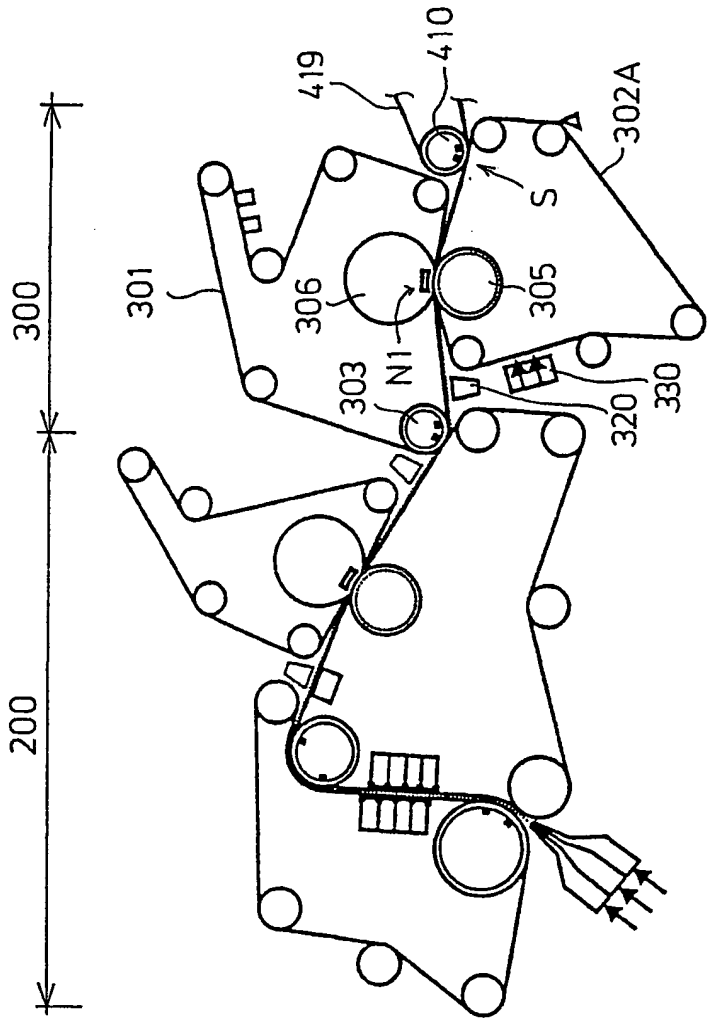

FIG. 6

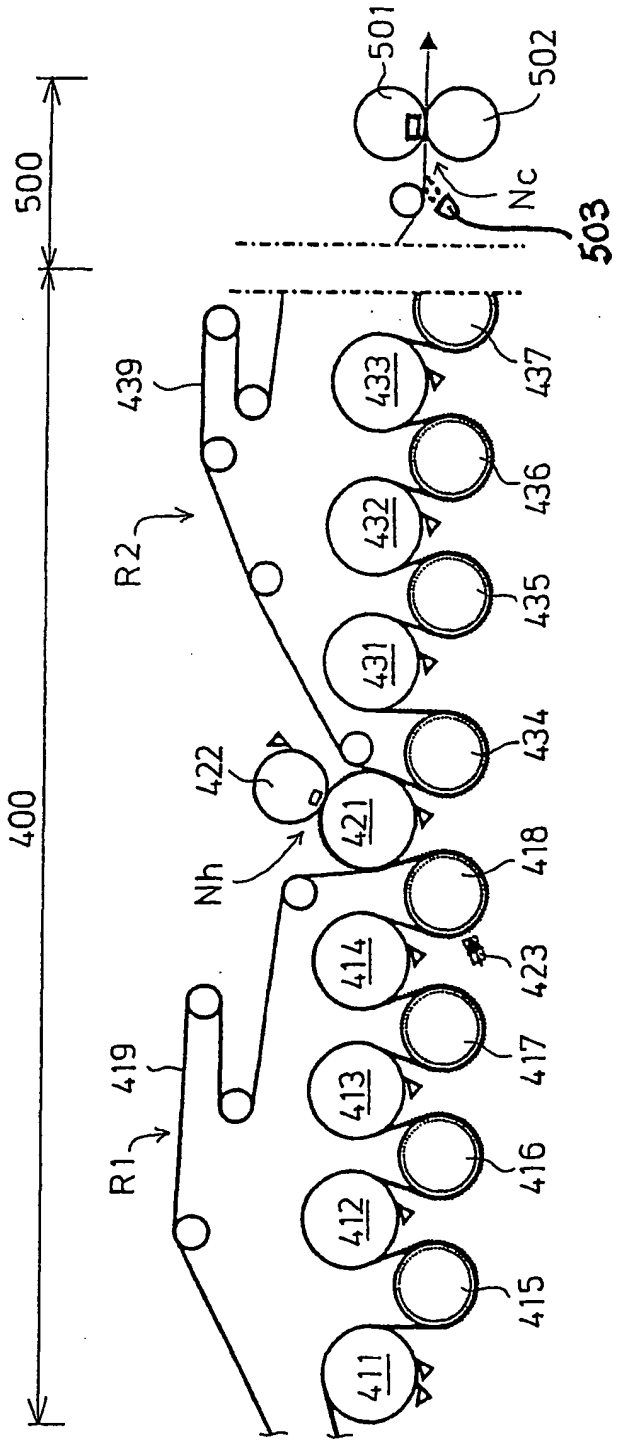
500
400
501
502
Nc
503
439
437
433
436
432
435
431
434
R2
422
421
418
Nh
414
423
417
419
413
416
R1
412
415
411

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 02/00349

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: D21F 3/00, D21F 11/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9964671 A1 (VALMET CORPORATION), 16 December 1999 (16.12.99) -- --------	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 August 2002	27 -08- 2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Olov Jensén/ELY Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

Information on patent family members

06/07/02

International application No.
PCT/FI 02/00349

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9964671 A1	16/12/99	AU 4268599 A	30/12/99
		EP 1086271 A	28/03/01
		FI 104100 B	00/00/00
		FI 981330 A	15/11/99